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VACCINE AND NON-PHARMACOLOGICAL MEASURES IN SEASONAL INFLUENZA PREVENTION: CURRENT EVIDENCE ON EFFECTIVENESS

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Abstract. Seasonal influenza remains a major cause of acute respiratory morbidity, excess hospitalization, and preventable mortality worldwide, especially among older adults, young children, pregnant women, people with chronic diseases, and healthcare workers. This article reviews current evidence on the effectiveness of vaccination and non-pharmacological measures in seasonal influenza prevention. The manuscript was prepared as a structured narrative review in IMRAD format using contemporary recommendations of the World Health Organization and the U.S. Centers for Disease Control and Prevention, together with systematic reviews, randomized trials, and recent vaccine effectiveness reports. The evidence shows that annual vaccination remains the most effective single preventive intervention and reduces medically attended influenza, hospitalization, and disease severity, although protection varies by age, circulating subtype, and antigenic match. Modern preventive strategy has moved toward more individualized vaccine selection for specific populations, including the use of enhanced formulations for older adults where available. Non-pharmacological measures, including hand hygiene, respiratory etiquette, staying home when ill, improvement of indoor air, surface hygiene, and the selective use of well-fitted masks, provide complementary benefit, particularly during periods of high transmission, in crowded settings, and in households or institutions with vulnerable persons. At the same time, evidence from randomized trials indicates that the effect of masks and hand hygiene alone may be modest when interventions are implemented late or adherence is poor. The most rational modern approach is therefore not to oppose vaccination to non-pharmacological measures, but to combine them in a layered prevention model. Such a model is especially important for high-risk groups, outbreak control, and seasons in which vaccine effectiveness is suboptimal.

Keywords: seasonal influenza, influenza vaccine, vaccine effectiveness, non-pharmacological measures, hand hygiene, masks, ventilation, prevention

ЭФФЕКТИВНОСТЬ ВАКЦИНЫ И НЕФАРМАКОЛОГИЧЕСКИХ МЕР В ПРОФИЛАКТИКЕ СЕЗОННОГО ГРИППА: СОВРЕМЕННЫЕ ДАННЫЕ

Аннотация. Сезонный грипп остается одной из ведущих причин острых респираторных заболеваний, избыточной госпитализации и предотвратимой смертности во всем мире, особенно среди пожилых людей, детей раннего возраста, беременных женщин, лиц с хроническими заболеваниями и медицинских работников. В статье

обобщены современные данные об эффективности вакцинации и нефармакологических мер в профилактике сезонного гриппа. Рукопись подготовлена в формате структурированного нарративного обзора по схеме IMRAD с использованием актуальных рекомендаций Всемирной организации здравоохранения и Центров по контролю и профилактике заболеваний США, а также систематических обзоров, рандомизированных исследований и недавних отчетов об эффективности вакцин. Анализ показывает, что ежегодная вакцинация остается наиболее эффективным отдельным методом профилактики и снижает частоту обращений за медицинской помощью по поводу гриппа, госпитализаций и тяжесть заболевания, хотя уровень защиты варьирует в зависимости от возраста, циркулирующего подтипа вируса и антигенного соответствия. Современная стратегия профилактики все чаще предполагает индивидуализированный выбор вакцины для отдельных групп населения, включая использование усиленных формул для пожилых пациентов там, где они доступны. Нефармакологические меры, такие как гигиена рук, респираторный этикет, пребывание дома во время болезни, улучшение качества воздуха в помещениях, гигиена поверхностей и избирательное применение хорошо прилегающих масок, обеспечивают дополнительный профилактический эффект, особенно в периоды высокой заболеваемости, в условиях скученности и в семьях или учреждениях, где находятся уязвимые лица. В то же время данные рандомизированных исследований показывают, что эффект только масок и гигиены рук может быть умеренным, если меры вводятся поздно или соблюдаются непоследовательно. Наиболее рациональный современный подход состоит не в противопоставлении вакцинации и нефармакологических мер, а в их сочетании в модели многоуровневой профилактики. Такая модель особенно важна для групп высокого риска, контроля вспышек и сезонов, в которых эффективность вакцины оказывается недостаточной.

Ключевые слова: сезонный грипп, вакцина против гриппа, эффективность вакцины, нефармакологические меры, гигиена рук, маски, вентиляция, профилактика

INTRODUCTION

Seasonal influenza continues to place a substantial burden on public health systems because it affects all age groups, recurs annually, and can rapidly lead to complications in vulnerable populations. Although influenza is often perceived as a self-limited illness, it remains associated with a considerable number of outpatient visits, hospital admissions, work and school absenteeism, and excess mortality during epidemic periods. The burden is unevenly distributed, with the highest clinical risk observed in older adults, children younger than five years, pregnant women, people with chronic diseases, and individuals with immunosuppression [1, 4, 5].

In modern preventive medicine, vaccination is considered the central strategy for reducing the burden of seasonal influenza. However, contemporary clinical practice has moved beyond a single-measure model. Alongside annual vaccination, public health agencies increasingly emphasize hand hygiene, respiratory etiquette, staying home during acute illness, indoor air improvement, environmental cleaning, and, in selected situations, mask use. The practical question is no longer whether one approach should replace the other, but how these measures

should be combined to achieve the greatest preventive effect in routine seasons and during periods of increased viral circulation [2, 11, 12].

The present article aims to summarize current evidence on the effectiveness of vaccination and non-pharmacological measures in seasonal influenza prevention and to analyze their place in a modern layered prevention strategy.

MATERIALS AND METHODS

This article was prepared as a structured narrative review in accordance with the IMRAD format. The review was based on contemporary publications and public health guidance documents addressing seasonal influenza prevention. Priority was given to the World Health Organization position paper on influenza vaccination, current CDC and ACIP recommendations, recent vaccine effectiveness reports, systematic reviews, meta-analyses, and randomized controlled trials that assessed vaccination or non-pharmacological interventions in community and household settings [1, 2, 3, 6, 7].

The analysis focused on four domains. The first domain was the preventive value of seasonal influenza vaccination in the general population and in high-risk groups. The second domain was the role of modern vaccine platforms and targeted vaccine selection in vulnerable populations. The third domain was the effectiveness of non-pharmacological interventions such as hand hygiene, respiratory etiquette, surface hygiene, ventilation, staying home when ill, and mask use. The fourth domain was the practical integration of these measures into a layered prevention model.

RESULTS

The reviewed evidence confirms that vaccination remains the most effective single intervention for preventing seasonal influenza and its serious outcomes. WHO continues to recommend seasonal influenza vaccination programs based on local disease burden and programmatic feasibility, while identifying health workers and older adults as the highest-priority groups, with pregnant women, individuals with chronic medical conditions, and children aged 6 to 59 months also considered priority populations [1]. CDC and ACIP currently recommend annual influenza vaccination for all persons aged six months and older without contraindications, with vaccination ideally offered during September or October and continued while influenza viruses are circulating [2].

Modern vaccination strategy is increasingly personalized. Traditional egg-based inactivated vaccines are still widely used, but current prevention policy also includes cell-based, recombinant, adjuvanted, high-dose, and live attenuated formulations. This diversification reflects an important shift in preventive thinking. The goal is no longer only to vaccinate broadly, but also to improve protection in groups whose immune response may be weaker or whose risk of severe disease is higher. For example, current ACIP guidance gives preference to high-dose inactivated, recombinant, or adjuvanted vaccines for adults aged sixty-five years and older where these options are available [2]. WHO also recognizes the growing role of enhanced vaccines for older adults in settings that can support their use [1].

The protective effect of seasonal influenza vaccination is not fixed from one year to another. It depends on the match between vaccine strains and circulating viruses, the dominant subtype in a given season, host factors, and previous exposure history. Nevertheless, even when

effectiveness is imperfect, vaccination usually reduces the probability of medically attended influenza, hospitalization, and severe outcomes. CDC's interim estimates for the 2024–2025 season showed that vaccination lowered the risk of influenza-associated outpatient visits and hospitalization in both children and adults, with reported estimates against hospitalization reaching from forty-one to fifty-five percent in adults and from sixty-three to seventy-eight percent in children and adolescents across participating networks [3]. These findings are consistent with broader CDC summaries indicating that annual vaccination reduces influenza illness, hospitalization, and even flu-related death, while also decreasing disease severity among breakthrough cases [4].

The benefit of vaccination is especially important in populations at increased risk of complications. Current CDC guidance highlights older adults, very young children, pregnant women, people with asthma, chronic lung disease, heart disease, kidney disease, liver disease, diabetes, neurologic disorders, obesity, immunosuppression, and residents of long-term care facilities as groups with higher risk of severe influenza outcomes [5]. In these populations, vaccination has a dual role. It lowers the probability of infection and also reduces the likelihood that infection will progress to decompensation of underlying disease, pneumonia, or hospitalization [4, 5].

Non-pharmacological measures remain relevant because vaccine-induced protection is never absolute, vaccine uptake is incomplete in many communities, and influenza transmission often occurs in households, schools, workplaces, and healthcare settings before laboratory confirmation is established. The most consistently recommended measures include hand hygiene, cough etiquette, reducing close contact with others during illness, cleaning frequently touched surfaces, and improving ventilation or air filtration in indoor environments [11, 12]. These interventions are biologically plausible, low-cost, and broadly applicable, especially in seasons with intense circulation or in settings where vulnerable individuals are present.

The evidence base for non-pharmacological measures, however, is more nuanced than the evidence base for vaccination. A 2025 systematic review and meta-analysis of household influenza interventions found limited randomized evidence that hand hygiene and face masks substantially reduce within-household transmission once an index case is already present, although some studies suggested that these measures may delay or reduce transmission when implemented very early after symptom onset [6]. The 2023 Cochrane review on physical interventions for respiratory viruses similarly concluded that randomized trial evidence for masks and hand hygiene is affected by heterogeneity, variable adherence, and methodological limitations, which makes the overall effect uncertain rather than definitively absent [7].

Earlier randomized trials provide useful clinical nuance. In a household cluster-randomized trial, Cowling and colleagues reported that facemasks and hand hygiene appeared more beneficial when introduced within thirty-six hours of symptom onset in the index case [8]. In a university-based randomized intervention trial, Aiello and colleagues found that face masks combined with hand hygiene reduced rates of influenza-like illness over the observation period, supporting the concept that combined interventions may perform better than single measures when adherence is adequate [9]. A systematic review and meta-analysis focused specifically on

hand hygiene also concluded that community-based hand hygiene can reduce the risk of influenza virus infection, although the size of effect varies across settings and studies [10].

Cleaner indoor air has become a more visible component of respiratory virus prevention in recent guidance. Both CDC and the U.S. Environmental Protection Agency emphasize that bringing in outdoor air, improving mechanical ventilation, optimizing HVAC filtration, and using fans or exhaust systems can help reduce the concentration of airborne respiratory viruses indoors [11, 12]. Ventilation alone is not sufficient to prevent transmission, but current evidence and public health guidance support its use as part of a broader layered strategy, particularly in homes, schools, offices, and healthcare environments during periods of elevated respiratory virus activity [11, 12].

DISCUSSION

The main finding of this review is that vaccination and non-pharmacological measures should not be viewed as competing strategies. Seasonal influenza prevention is most effective when built on a layered model in which vaccination provides the primary biologic protection and non-pharmacological measures reduce exposure risk and secondary spread. This model is especially important because influenza vaccine effectiveness varies by season. A year with moderate vaccine effectiveness does not negate the value of vaccination. On the contrary, it strengthens the rationale for combining vaccination with everyday preventive behaviors and environmental measures [2, 3, 4].

Another important point is that the effectiveness of non-pharmacological measures is highly dependent on timing, adherence, and context. Randomized trials that fail to show a large average effect do not necessarily mean that these measures are useless in practice. Influenza transmission often begins early, sometimes before interventions are adopted consistently. Household studies in particular are vulnerable to delayed implementation, incomplete compliance, and behavioral contamination between study groups. This helps explain why pooled estimates are often modest, while clinically meaningful benefit may still exist when measures are introduced promptly, used correctly, and combined rather than applied in isolation [6, 7, 8, 9].

From a practical standpoint, modern influenza prevention should be risk-stratified. For the general population, annual vaccination remains the first recommendation. During community outbreaks or in settings with crowded indoor contact, hand hygiene, respiratory etiquette, staying home while febrile or acutely ill, and cleaner air measures should be reinforced. In households with infants, older adults, pregnant women, or immunocompromised members, an additional layer such as mask use during close indoor contact may be justified, especially at the beginning of illness in an index case. In hospitals, long-term care facilities, and similar institutions, the threshold for combining measures should be even lower because the consequences of transmission are greater [1, 2, 5, 11, 12].

The reviewed evidence also highlights the growing importance of targeted vaccination strategies. The expansion of recombinant, cell-based, adjuvanted, and high-dose vaccines reflects an effort to improve effectiveness in specific groups rather than relying only on universal recommendations. This shift is clinically meaningful for older adults and for health systems that seek to reduce influenza-related hospitalization during severe seasons [1, 2]. Therefore, the modern approach to influenza prophylaxis can be summarized as adaptive and population-

sensitive. It prioritizes the right vaccine, for the right person, at the right time, while maintaining simple non-pharmacological practices that reduce transmission opportunities.

This review has limitations. It is a structured narrative review rather than a de novo systematic review. In addition, some guidance documents are country-specific and therefore reflect the organization of particular health systems. Nevertheless, the central conclusions are stable across sources. Vaccination remains the cornerstone of prevention, while non-pharmacological measures have a complementary role that becomes especially relevant when risk is high, uptake is incomplete, or transmission intensity increases.

CONCLUSION

Seasonal influenza prevention in modern clinical and public health practice should be based on a layered strategy rather than on a single intervention. Annual vaccination remains the most effective standalone measure and has the strongest evidence for reducing illness, hospitalization, and severe outcomes. At the same time, hand hygiene, respiratory etiquette, cleaner indoor air, staying home during acute illness, environmental hygiene, and selective mask use add practical value, especially in high-risk groups, crowded settings, and early household exposure.

The available evidence supports a balanced conclusion. Vaccination should remain the central pillar of seasonal influenza prophylaxis, while non-pharmacological measures should be used as rational complements rather than symbolic alternatives. The most effective prevention model is therefore one that combines immunization with timely behavioral and environmental measures adapted to the level of risk, the clinical setting, and the epidemiologic characteristics of the season.

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